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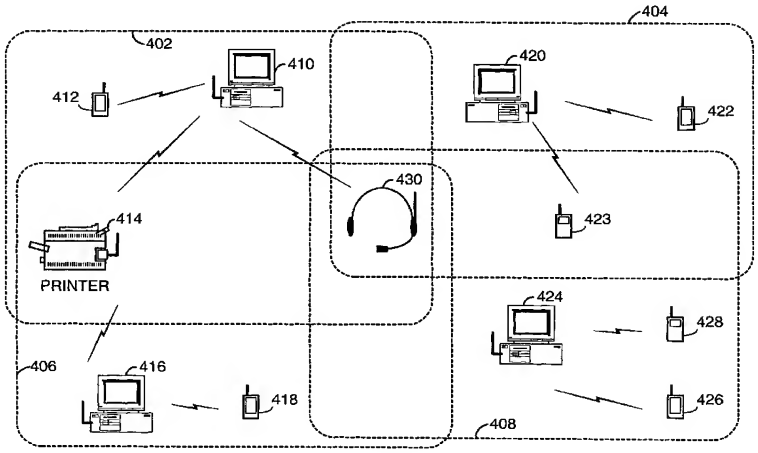
(54) Title: WIRELESS DEVICE AUTHENTICATION AT MUTUAL REDUCED TRANSMIT POWER



(57) Abstract: A system and method for facilitating the authentication of wireless devices in an environment with multiple wireless networks. A user wishing to join an operating wireless network can bring his wireless device (430) within close physical proximity, for example, less than one meter, of a device (410) in the network (402) that he wishes to join. The user then presses an authenticate button, which causes both devices (410 and 430) to enter a low transmission power mode. In such case, the devices (410 and 430) are only capable of operation within the close proximity. Being in low power mode will diminish the possibility of eavesdropping on the authentication process. Power down mode also reduces the amount of message traffic in the area and saves scarce power and processing resources at the nodes, which are now out of range. Authentication then takes place in low power mode and once completed, both devices resume normal power levels and continue communicating normally.

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TITLE: WIRELESS DEVICE AUTHENTICATION AT MUTUAL REDUCED TRANSMIT POWER

SPECIFICATION

1. FIELD OF THE INVENTION

The present invention relates to wireless communications; and more particularly to wireless network communications.

2. BACKGROUND OF THE INVENTION

The number and popularity of wireless communications devices in use continues to rise rapidly all over the world. Not only are mobile phones very popular, but there is also a demand for wireless networking devices. One standard for wireless networking, which has been widely accepted, is the Specification of the Bluetooth System, v. 1.0 ("Bluetooth Specification"). The Bluetooth Specification continues to evolve and subsequent versions are expected to be available.

The Bluetooth Specification enables the creation of small personal area networks (PAN's), where the typical operating range of a device is 100 meters or less. In a Bluetooth system, the wireless Bluetooth devices sharing a common channel form a piconet. Two or more piconets co-located in the same area, with or without inter-piconet communications, is known as a scatternet. It is anticipated that as piconets are setup there could be several piconets operating in the same area as a scatternet, but not necessarily linked together.

The need to have security procedures in wireless networks has led to security, encryption and authentication procedures and protocols being incorporated as part of the Bluetooth Specification, in Volume 1, part B, Section 14: Bluetooth Security, of the Specifications of the Bluetooth System, v. 1.0, as referenced above.

When a wireless Bluetooth device tries to connect to a particular piconet, it must go through an authentication process, where a user that is part of that piconet, allows the guest to join the piconet. Typical wireless network devices such as computers, personal digital assistants (PDAs) and mobile phones, have a display and a keyboard that facilitate the authentication process. When a user with a mobile phone enters into the operating range of a piconet, he will get a message telling what piconet, with a particular ID, he has just entered and he can signal his intention to join that piconet by pressing the appropriate key on his keypad. When he presses the appropriate key, he will start the process of joining that piconet.

When the guest entered into range of the piconet, his PIN was sent to and received by the devices in the piconet. His PIN can then be shown on the displays of the devices in the piconet. A user in the piconet can then respond to the guest's request and he can accept or deny the guest's request to join that piconet. Eavesdropping during the registration process makes Bluetooth devices particularly vulnerable to security breaches.

When a guest enters an area with several operating piconets, his display will show him the ID's of the piconets he has discovered. The guest can then choose which piconet to join using his keypad. But when the guest has a minimal user interface, such as a wireless headset, he has not ability to signal his choice of which piconet to join. In such case, the headset may be paired to work only with a paired device. This paired device may also have a limited user interface, and not have a display or keypad.

There is a need for a system, protocol and procedure to enable wireless devices, such as headsets, to join a particular piconet. There is also a need to improve security by reduce the possibility of eavesdropping on the authentication process. There is also a need to avoid burdening nearby nodes with the extra traffic caused by authentication.

SUMMARY OF THE INVENTION

Operation according to the present invention enables wireless devices to select and join a particular wireless network with minimal user interaction and with ease in selection of the network. According to the present invention, after selection of a network and request for admission to the network, reduced power operations are performed during corresponding authentication operations. Reduced power authentication operations ensure that admission to the selected network is attempted and not with a different network. Further, the reduced power operations minimize the ability of eavesdropping devices to intercept authentication information

One technique for implementing these reduced power authentication operations is to first select a master device of the wireless network for the purpose of requesting a connection to the wireless network. With the master device selected, a user places the new device a distance from the master device of the wireless network. This reduced distance is substantially less than the maximum operating range of the devices. The new device then sends a message to the master device that requests that the new device join the wireless network. Upon receipt of this message, both the new device and the master device reduce their radio frequency power outputs to a power level sufficient to maintain radio

communications between the devices at the reduced distance. The new device then processes the request, approves the request, and authenticates the new device into the wireless network. Once these operations are complete, the new device and the master device increase their the radio frequency power outputs to normal power levels.

Using this operating technique, a user of a wireless device having a minimal (or no) user interface, e.g., a wireless headset, may easily select a particular network. With the master device and the new device reducing their transmit power during the joining operations, joining a desired network is substantially guaranteed. Further, with the reduced power operations of the present invention, minimal user input is required for the joining operations. Moreover, when multiple networks are present, e.g., a scatternet, the user of the new device may easily select a desired network from a plurality of networks having overlapping coverage area.

Other features and advantages of the present invention will become apparent from the following detailed description of the invention made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates in a block diagram, a point-to-point network between two wireless devices;

Figure 2 illustrates in a block diagram, a point to multipoint network among a plurality of wireless devices;

Figure 3 illustrates in a block diagram, a scatternet that includes multiple piconets with overlapping coverage;

Figure 4 is a system diagram illustrating a scatternet in which one operation according to the present invention is performed;

Figure 5 is a logic diagram illustrating operation according to the present invention; and

Figure 6 is a block diagram generally illustrating the structure of a wireless device constructed according to the present invention.

DETAILED DESCRIPTION

Figure 1 illustrates a network 10 that includes two wireless devices 102-1 and 102-2. Network 10 is, for example, a wireless Bluetooth point-to-point piconet where wireless

device 102-1 is a master Bluetooth system and wireless device 102-2 is a slave Bluetooth system, where the master 102-1 and slave 102-2 share the same channel. The point-to-point network 10 described with reference to Figure 1 need not include Bluetooth devices 102-1, 102-2, but, rather, may comprise any type of wireless device. These wireless devices 102-1 and 102-2 may include digital computers, computer peripherals such as printers, scanners, mice, keyboards, etc., personal data assistants (PDAs), wireless telephones, wireless headsets, and other wireless devices.

Figure 2 illustrates a network 20 that includes a plurality of wireless devices 102-1, 102-2... 102-i ... 102-n ($2 \leq i \leq n$). Wireless network 20 is, for example, a point-to-multipoint Bluetooth piconet where wireless device 102-1 is a master Bluetooth system and wireless devices 102-2 through 102-n are slave Bluetooth systems and communicate with the master Bluetooth system 102-1 over the same channel. In at least one embodiment, up to seven slaves can be active in the piconet 102. The number of active slaves supported in a piconet depends on many variables and design considerations. The point-to-point network of Figure 2 need not include Bluetooth devices 102-1, 102-2, but, rather, may comprise any type of wireless device.

In addition to the active slaves 102-2, 102-i through 102-n illustrated in Figure 2, a point-to-multipoint piconet 20 may include many additional slaves that can remain locked to the master 102-1 in a so-called "parked" state. When a slave does not need to participate on the piconet channel, but still needs to remain synchronized to the channel it can enter the parked state. These parked slaves cannot be active on the piconet channel, but still remain synchronized to the master.

For both active and parked slaves in a single piconet 20 (or piconet 10 of Figure 1), the master 102-1 controls channel access. To this end, the master 102-1 switches control from one slave to another as it controls channel access within the piconet 20. The master 102-1 identifies each slave through a unique network address assigned to each slave. When a transfer of information between two slaves in a piconet 10 is desired, the master 102-1 coordinates point-to-point transmission between the two slaves.

Referring to Figure 2, for instance, slave 102-2 could be a wireless personal digital assistant ("PDA") device equipped with a Bluetooth system and slave 102-i could be a wireless cellular telephone equipped with a Bluetooth system. In such a case, the master 102-1 can coordinate communications between two slaves 102-2, 102-i over the piconet channel to exchange, for instance, phone number information. To do so, the master 102-1 switches

focus between the first slave 102-2, commanding it to transmit phone number data to the master 102-1, and the second slave 102-i, commanding it to receive phone number data from the master 102-1. This switch in focus is performed by the master through its storing and accessing context information regarding each slave in a relatively rapid succession.

Figure 3, illustrates, for instance, a "scatternet", formed from multiple piconets with overlapping coverage. Bluetooth piconets 20, 31, 33, and 37 form part of the larger Bluetooth scatternet 30. Each piconet 20, 31, 33, and 37 has only a single master 102-1, 36, 36, and 34 respectively. However, Figure 3 also illustrates that slaves can participate in multiple piconets on a time-division multiplex basis. For instance, in Figure 3, slave 32 participates in two piconets: piconet 20 having master 102-1 and piconet 31 having master 36. In addition, a master 34 in one piconet 33 can be a slave in another piconet 37. Further, a single Bluetooth system may serve as a master in two piconets, e.g., Bluetooth system 36 serves as a master in both piconet 31 and piconet 37.

Figure 4 is a system diagram illustrating a scatternet in which one operation according to the present invention is performed. The scatternet of Figure 4 includes four separate piconets 402, 404, 406, and 408. Piconet 402 includes master (computer) 410, slave 412 (PDA), and slave 414 (printer). Piconet 404 includes master 420 (computer), slave 422 (PDA), and slave 423 (wireless phone). Piconet 406 includes master (computer) 416, slave 418 (PDA), and slave 414 (printer). Piconet 408 includes master (computer) 424, slave 426 (PDA), and slave 428 (wireless phone). The four separate piconets 402, 404, 406, and 408 have overlapping coverage areas. In the embodiment of Figure 4, all masters are shown to be computers because they will typically be stationary and have the processing capability to service a number of slaves. However, in other embodiments, the masters could be other devices as well. The scatternet of Figure 4 may service a call center, customer service department, or other office environment, for example that benefits by the wireless interconnection of the illustrated devices.

A user of wireless headset 430 desires to have the wireless headset 430 join piconet 402 (corresponding to his home computer). The wireless headset 430 has a minimal user interface, e.g., a single authenticate button that initiates joining of a piconet. However, the wireless headset 430, in its operating location, resides within the service coverage area of each of the four separate piconets 402, 404, 406, and 408 that form the scatternet. According to prior techniques, the user of the wireless headset 430 would have difficultly in selecting

the desired piconet 402 because of the minimal user interface components of the wireless headset 430.

Thus, according to the present invention, when the wireless headset 430 enters (or powers up in) an area with more than one functioning piconet, the wireless headset 430 uses physical proximity, an authenticate button and a power down procedure to start the authentication process. The user of the wireless headset 430 physically approaches within close proximity, e.g., less than one meter, the master 410 servicing the piconet 402 that he wishes to join. Then, the user presses the authenticate button, signaling his intention to join the particular piconet 402.

Once the authenticate button has been pushed, both nodes, the master 410 and the slave 430 power down to a level that is usable within the one meter close proximity range. In the described embodiment, power down mode will work only if the distance between the devices is less than 1 meter. Power down mode increases the security of the authentication process, by minimizing message traffic, which could be received by other devices and other piconets. Power down mode increases the security of the authentication process, by preventing most other devices in the area from snooping or eavesdropping on the authentication process. Further, power down mode minimizes or eliminates any confusion regarding which piconet that the user wishes to join.

By minimizing air traffic during authentication, the other users and piconets have a better chance of maintaining stable communication. For example, if a piconet were hit with a lot of message traffic from users just walking by the piconet, scarce processing and power resources could be wasted in evaluating the new message traffic. This could bring regular traffic in the piconet to a standstill. Power down mode thus prevents the devices that are now out of range, from being disturbed by the authentication process.

In one operation of the present invention, the user on the piconet 402 that is within close proximity will get a message on the display of the master 410. The message would typically display the PIN of the guest 430 trying to join the piconet 402 along with a message stating his request to join. The user on the piconet 402 would then either allow or disallow the guest 430 attempting to join the piconet 420.

Authentication granted by the process could be temporary or permanent. When authentication is complete, then a confirming message can be sent to both devices. The wireless headset 430 user could receive a confirming tone to indicate completion of authentication. If authentication is not successful, that could also generate a message to one

or both of the devices 410 and 430. Once authentication is complete, then normal power mode can be resumed and the guest (wireless headset 430) is now part of that piconet 402 and normal communications continue.

Figure 5 is a logic diagram illustrating operation according to the present invention. The logical operations described with reference to Figure 5 will include references to the devices of Figure 4. Operation commences when a guest (wireless handset 430) is placed within close proximity of a master (computer 410), e.g., 1 meter (step 502). With the guest 430 in close proximity to the master 410, a user of the guest 430 presses an authenticate button to initiate the joining of a piconet 402 serviced by the master 410 (step 504). The master 410 and the guest 430 then enter a power down mode in which the transmit power of each device is reduced (step 506). The transmit power during the power down mode is such that devices outside of the proximate distance between the devices 410 and 430 cannot eaves drop upon the authentication operations unless they are also proximately located. Thus, during the power down mode operations, the guest 430 should not be proximately located to other master devices.

Authentication operations are then performed in the power down mode (step 508). If the authentication operations are successful (as determined at step 510), normal power operations are resumed (step 512) and wireless communication operations are serviced until completion (step 514) at which point operation ends. If the authentication operations are not successful (as determined at step 510), operations end. After a successful authentication operation, confirmation of such success may be communicated to the user of the guest 430, e.g., the delivery of a distinctive tone to the user of the wireless headset 430.

Figure 6 is a block diagram generally illustrating the structure of a wireless device constructed according to the present invention. The general structure of the wireless device 600 will be present in any of the wireless devices illustrated in Figures 1-4, either master devices or slave devices. The wireless device 600 of Figure 6 implements the operations of Figure 5. The wireless device 600 includes a plurality of host device components 602 that service all requirements of the wireless device 600 except for the wireless requirements of the wireless device 600. Of course, operations relating to the wireless communications of the wireless device 600 will be partially performed by the host device components 602.

Coupled to the host device components 602 is a Radio Frequency (RF) interface 604. The RF interface 604 services the wireless communications of the host device 600 and includes an RF transmitter 606 and an RF receiver 608. The RF transmitter 606 and the RF

receiver 608 both couple to an antenna 610. The teachings of the present invention are embodied within the RF transmitter 606 of the RF interface 604 and are generally referred to as reduced power authentication operations. During these operations, the transmit power of the RF transmitter 606 is reduced to effectively reduce the operating range of the RF interface 604. During these reduced power operations, the operations of the RF receiver 608 may remain unchanged.

CLAIMS

1. In the operation of a wireless network managed by a master device, a method for adding a new device to the wireless network, the method comprising:

selecting the master device of the wireless network for the purpose of requesting to join the wireless network;

placing the new device a proximate distance from the master device of the wireless network, wherein the proximate distance between the master device and the new device is substantially less than the maximum operating range of the devices;

sending a message from the new device to the master device, the message conveying a request from the new device to join the wireless network;

reducing the radio frequency transmission power outputs of the new device and the master device to reduced power levels that are sufficient to maintain radio communications between the devices at the proximate distance;

sending, from the new device to the master device at a reduced power level, a request to join the wireless network;

authenticating the new device into the wireless network;

responding, by the master device to the new device at a reduced power level, that the new device has joined the wireless network; and

increasing the radio frequency power outputs of the new device and the master device to normal power levels.

2. The method of claim 1, wherein:

a plurality of other wireless networks provide overlapping coverage with the wireless network; and

reducing the radio frequency power outputs of the new device and the master device to a power level sufficient to maintain radio communications between the devices at the reduced distance prevents the request from being received by masters of the other wireless networks.

3. The method of claim 1, wherein reducing the radio frequency power outputs of the new device and the master device to a power level sufficient to maintain radio communications between the devices at the reduced distance prevents the request from being intercepted by eavesdropping wireless networks.

4. The method of claim 1, wherein the wireless network operates according to the Bluetooth Specification.

5. The method of claim 4, wherein:

the wireless network is a piconet serviced by the master device;

the piconet is one of a plurality of piconets that form a scatternet; and

the piconet of the plurality of piconets that form the scatternet is selected by placing the new device within proximity of the master device.

6. The method of claim 1, wherein the reduced power level of the new device differs slightly from the reduced power level of the master device.

7. The method of claim 1, wherein the new device has limited user interface capabilities.

8. The method of claim 1, wherein:

the new device has limited user interface capabilities; and

the new device indicates to its user that it has joined the wireless network.

9. A method for connecting a first device to a second device in a wireless network, the first and second devices being compatible and capable of forming a wireless network, and the wireless network operating within a particular geographic area, comprising the steps of:

selecting the second device out of a plurality of compatible devices for the purpose of forming a wireless network;

placing the first device a distance from the second device, the distance between the devices being less than the normal operating range between the devices;

receiving a command from the user of the first device, to send a message to the second device, the message conveying a request from the first device to the second device to form a wireless network;

reducing the radio frequency power outputs of the first and the second devices to a power level sufficient to maintain radio communications between the devices at the reduced distance;

sending a message from the first device to the second device, requesting permission to form a wireless network;

processing at the second device, the request from the first device to form a wireless network;

receiving at the second device, approval for the first and second devices to form a wireless network;

authenticating the first device into a wireless network with the second device; and

increasing the radio frequency power outputs of the first and second devices to normal power levels.

10. The method of claim 9, wherein:

a plurality of other wireless networks provide overlapping coverage with the wireless network; and

reducing the radio frequency power outputs of the first and the second devices to a power level sufficient to maintain radio communications between the devices at the reduced distance prevents the request from being received by masters of the other wireless networks.

11. The method of claim 9, wherein reducing the radio frequency power outputs of the first and the second devices to a power level sufficient to maintain radio communications between the devices at the reduced distance prevents the request from being intercepted by eavesdropping wireless networks.

12. The method of claim 9, wherein the wireless network operates according to the Bluetooth Specification.

13. The method of claim 12, wherein:

the wireless network is a piconet serviced by the second device;

the piconet is one of a plurality of piconets that form a scatternet; and

the piconet of the plurality of piconets that form the scatternet is selected by placing the first device within proximity of the second device.

14. The method of claim 9, wherein the reduced power level of the first device differs slightly from the reduced power level of the second device.

15. The method of claim 9, wherein the first device has limited user interface capabilities.

16. The method of claim 9, wherein:

the first device has limited user interface capabilities; and

the first device indicates to its user that it has joined the wireless network.

17. In the operation of a wireless network managed by a master device, a method for adding a new device to the wireless network, the method comprising:

selecting the master device of the wireless network for the purpose of requesting to join the wireless network;

placing the new device a proximate distance from the master device of the wireless network, wherein the proximate distance between the master device and the new device is substantially less than the maximum operating range of the devices, and wherein the new device has limited user interface capabilities;

receiving an indication from the new version device that a corresponding user has depressed a user interface button of the version device;

in response to the depression of the user interface button of the new version device, sending a message from the new device to the master device, the message conveying a request from the new device to join the wireless network;

reducing the radio frequency transmission power outputs of the new device and the master device to reduced power levels that are sufficient to maintain radio communications between the devices at the proximate distance;

sending, from the new device to the master device at a reduced power level, a request to join the wireless network;

authenticating the new device into the wireless network;

responding, by the master device to the new device at a reduced power level, that the new device has joined the wireless network; and

increasing the radio frequency power outputs of the new device and the master device to normal power levels.

18. The method of claim 17, wherein:

a plurality of other wireless networks provide overlapping coverage with the wireless network; and

reducing the radio frequency power outputs of the new device and the master device to a power level sufficient to maintain radio communications between the devices at the reduced distance prevents the request from being received by masters of the other wireless networks.

19. The method of claim 17, wherein reducing the radio frequency power outputs of the new device and the master device to a power level sufficient to maintain radio communications between the devices at the reduced distance prevents the request from being intercepted by eavesdropping wireless networks.

20. The method of claim 17, wherein the wireless network operates according to the Bluetooth Specification.

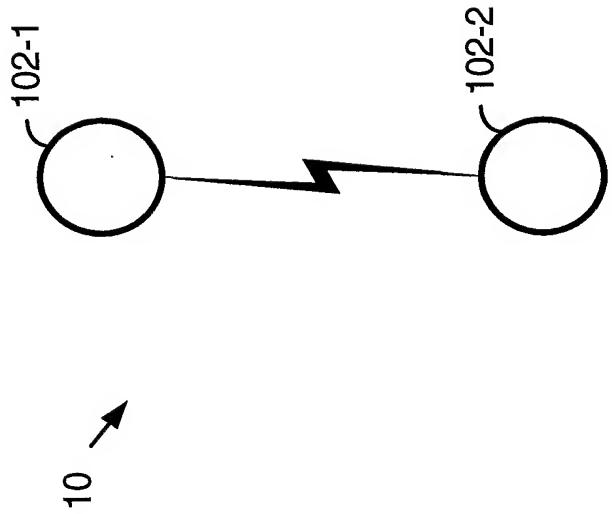

FIG. 1

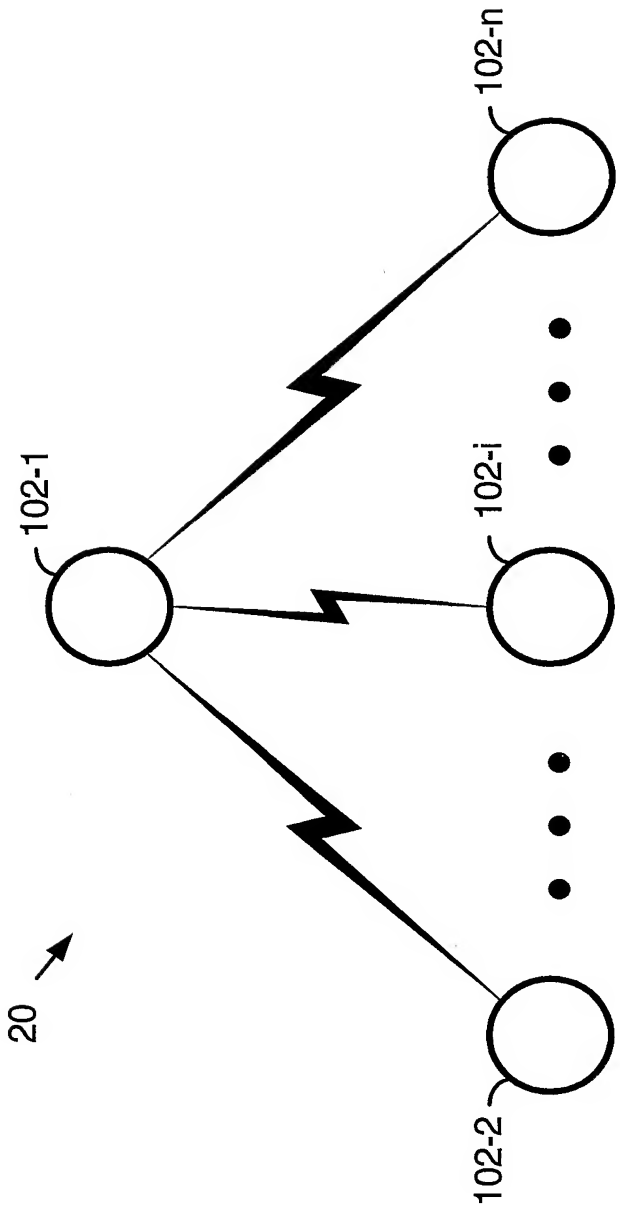

FIG. 2

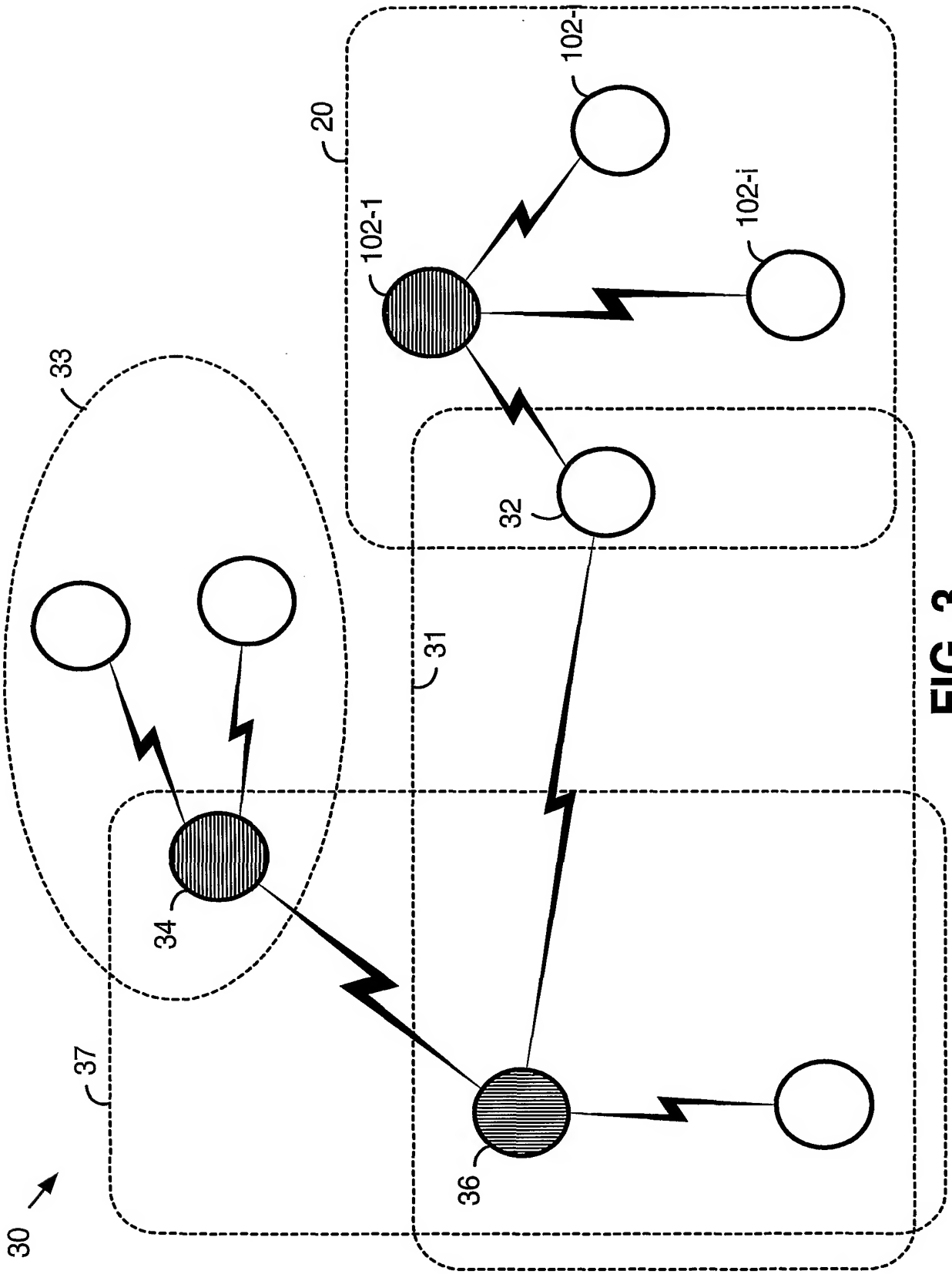

FIG. 3

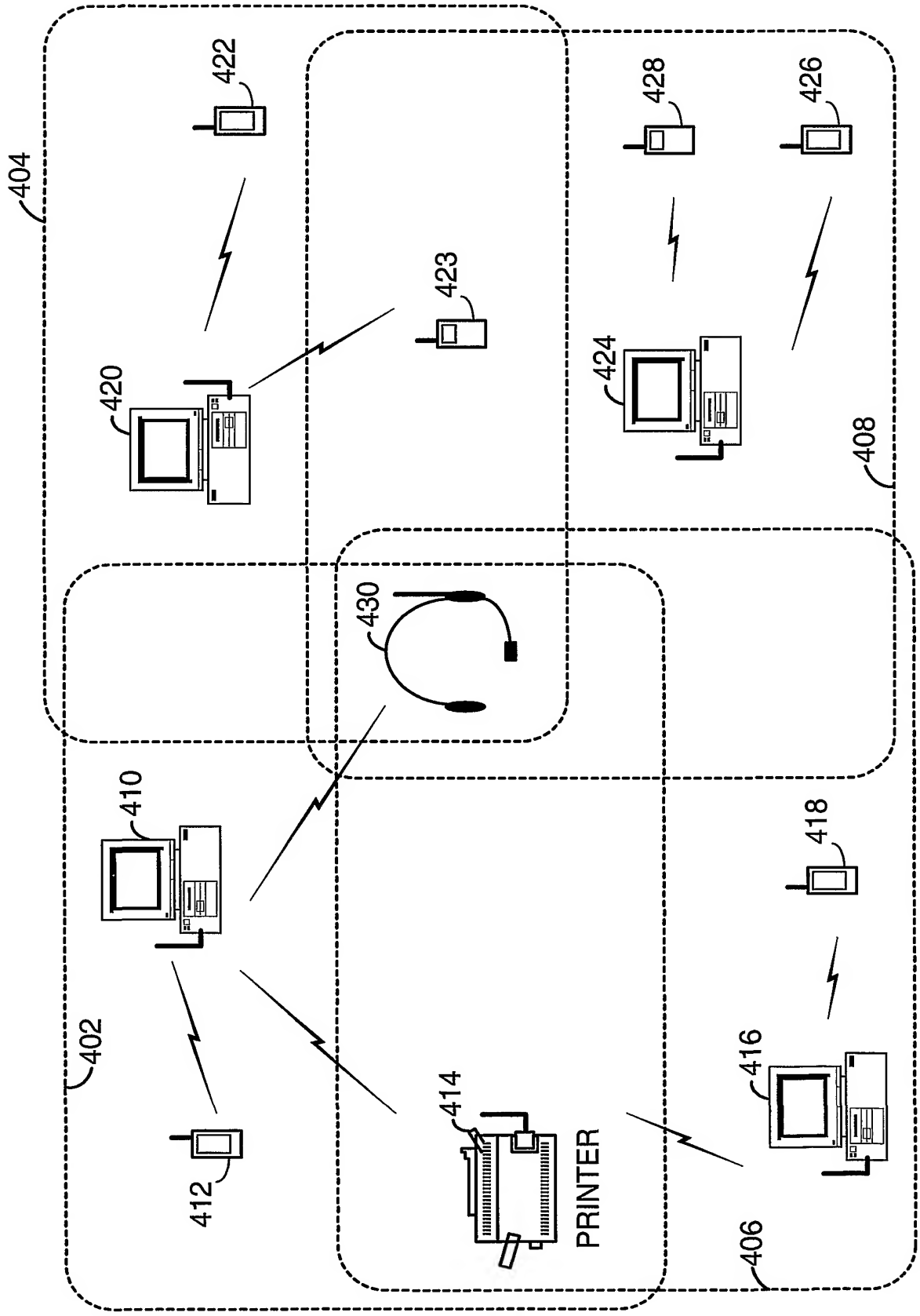
404
422
428
426
423
420
424
408
430
410
418
402
414
PRINTER
416
412
406

FIG. 4

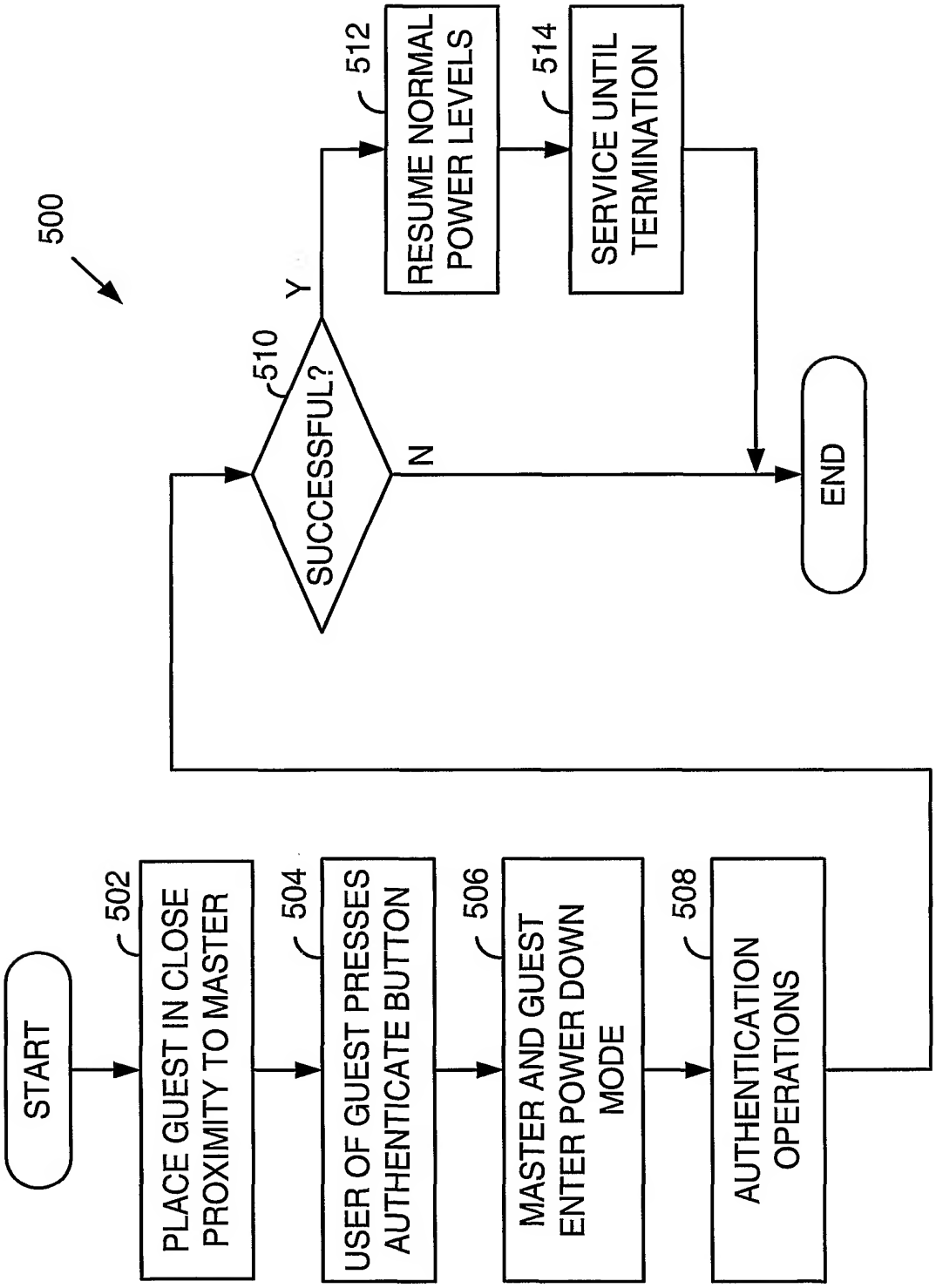
500
START
502
PLACE GUEST IN CLOSE PROXIMITY TO MASTER
504
USER OF GUEST PRESSES AUTHENTICATE BUTTON
506
MASTER AND GUEST ENTER POWER DOWN MODE
508
AUTHENTICATION OPERATIONS
510
SUCCESSFUL?
Y
N
512
RESUME NORMAL POWER LEVELS
514
SERVICE UNTIL TERMINATION
END

FIG. 5

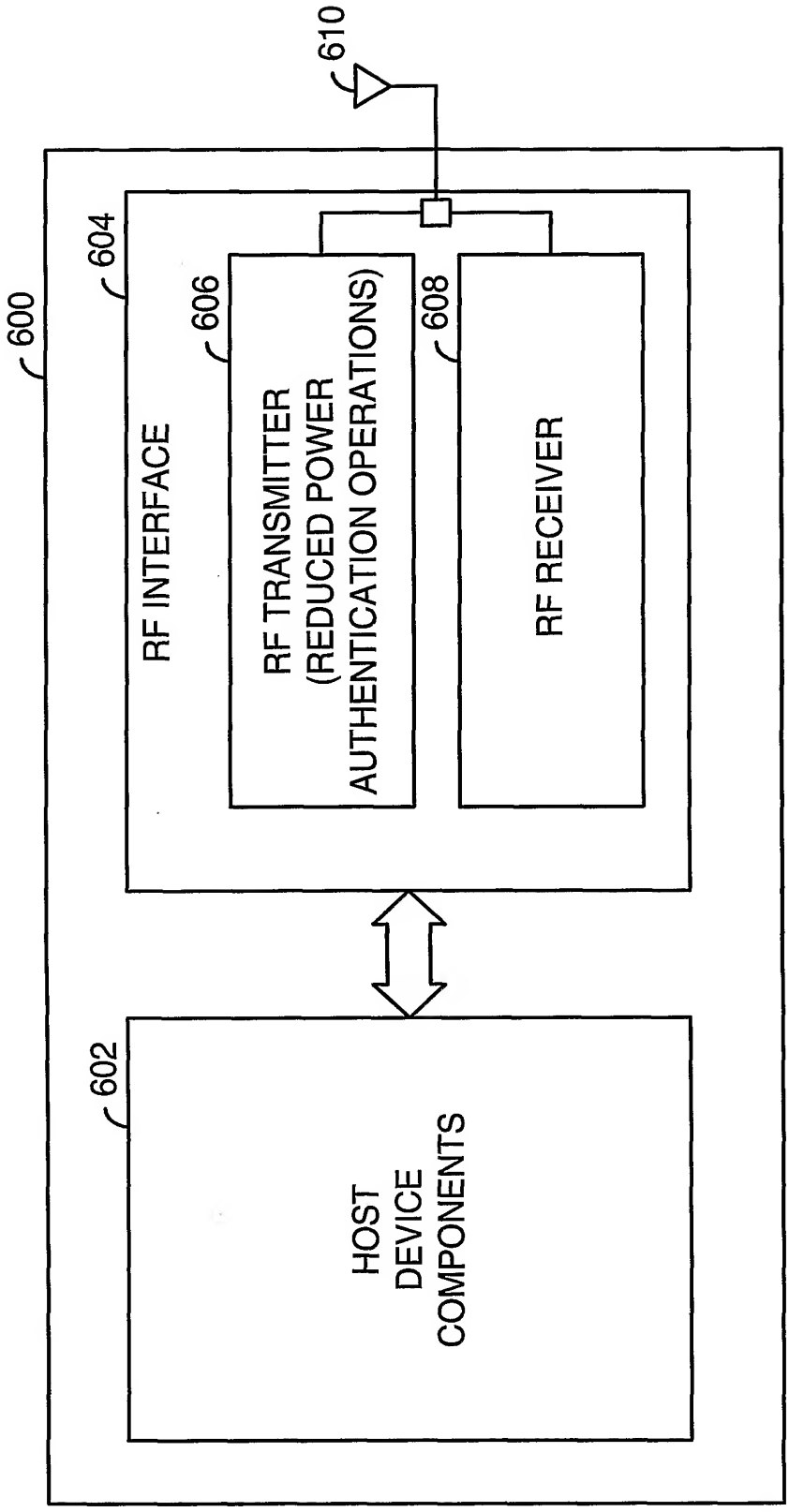
610
600
604
RF INTERFACE
606
RF TRANSMITTER
(REDUCED POWER
AUTHENTICATION OPERATIONS)
608
RF RECEIVER
602
HOST
DEVICE
COMPONENTS

FIG. 6